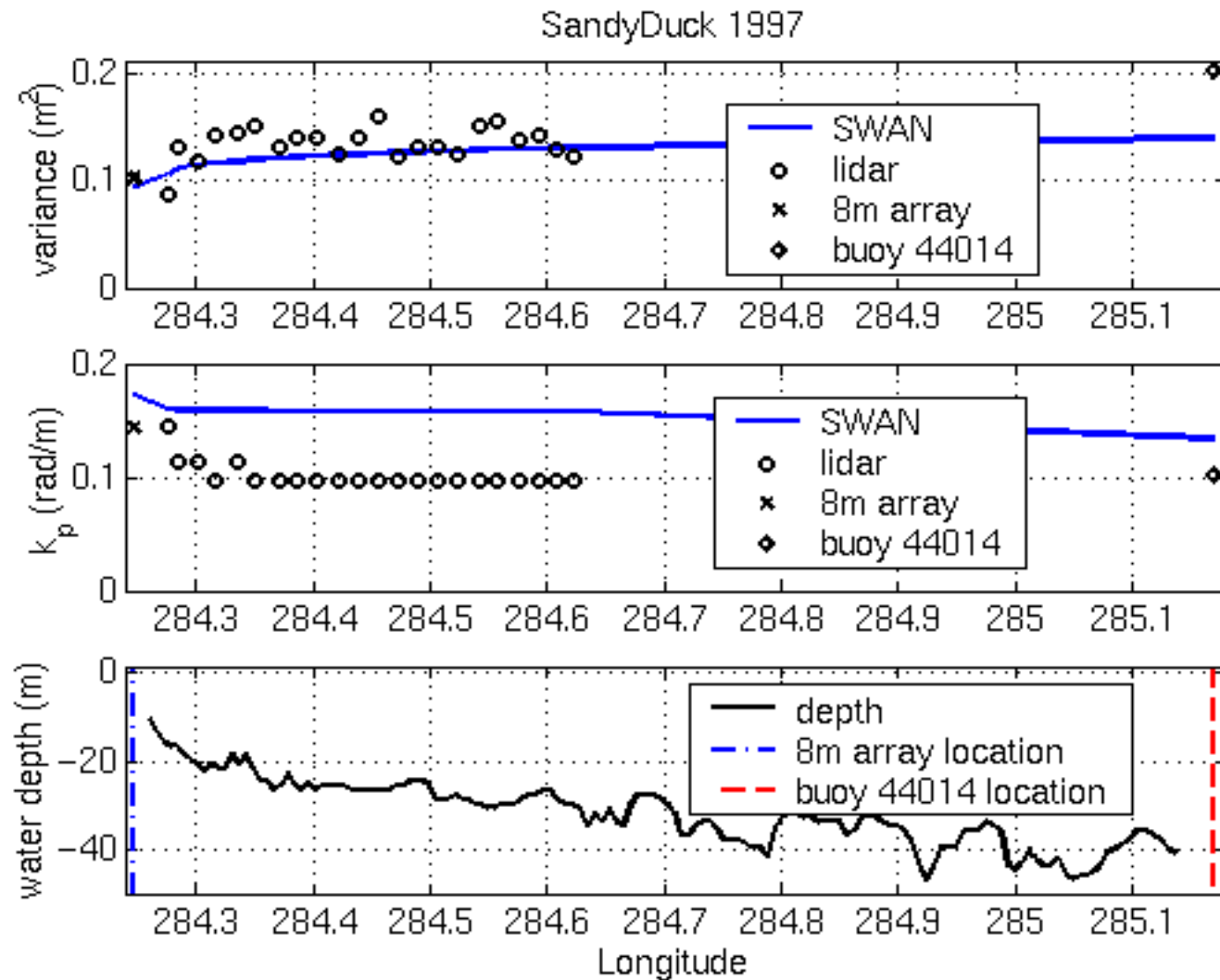


SWAN model analysis using a Lake Michigan storm event

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Waves In Shallow Environments Meeting
Spring 2000

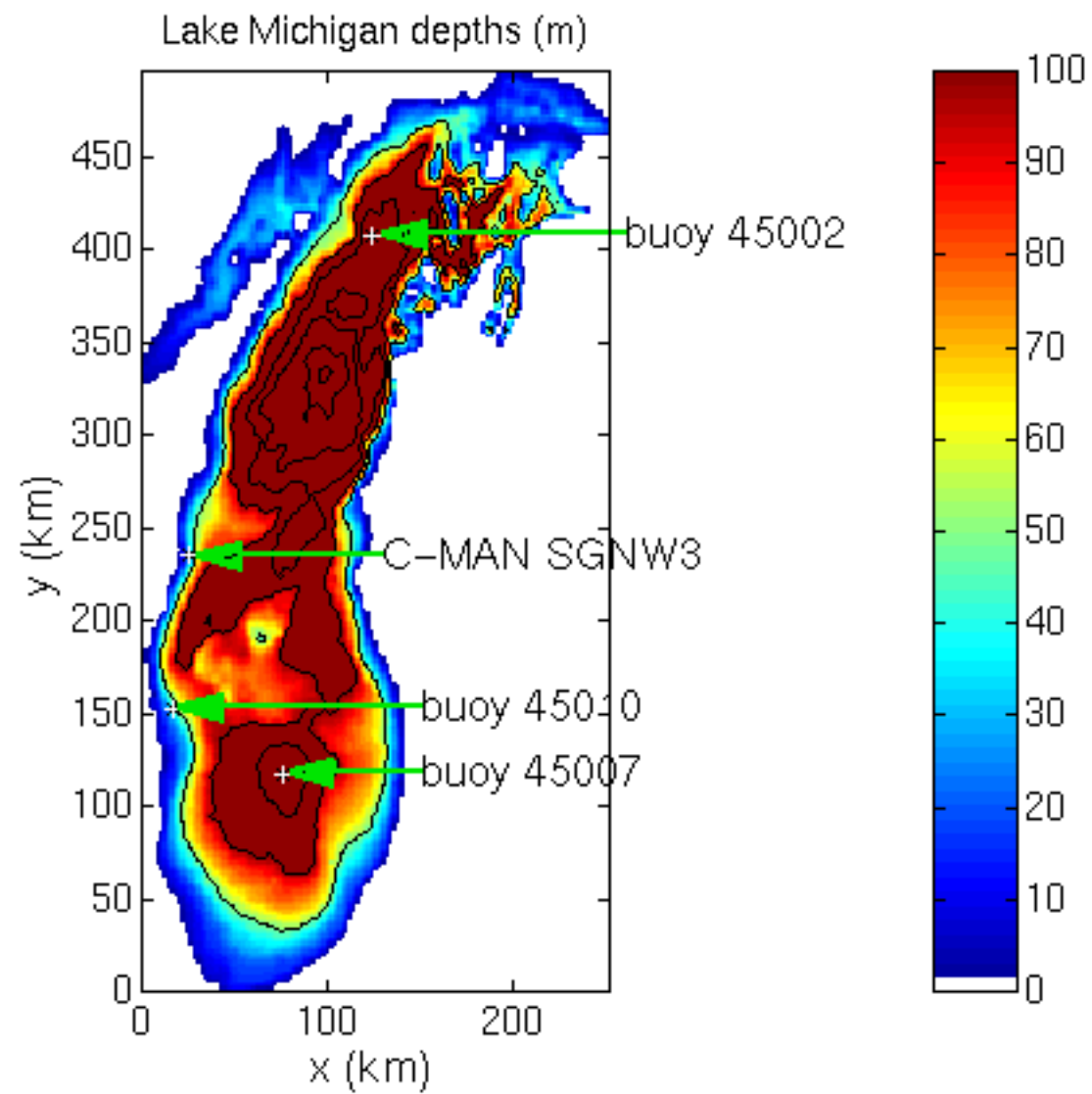
Motivation



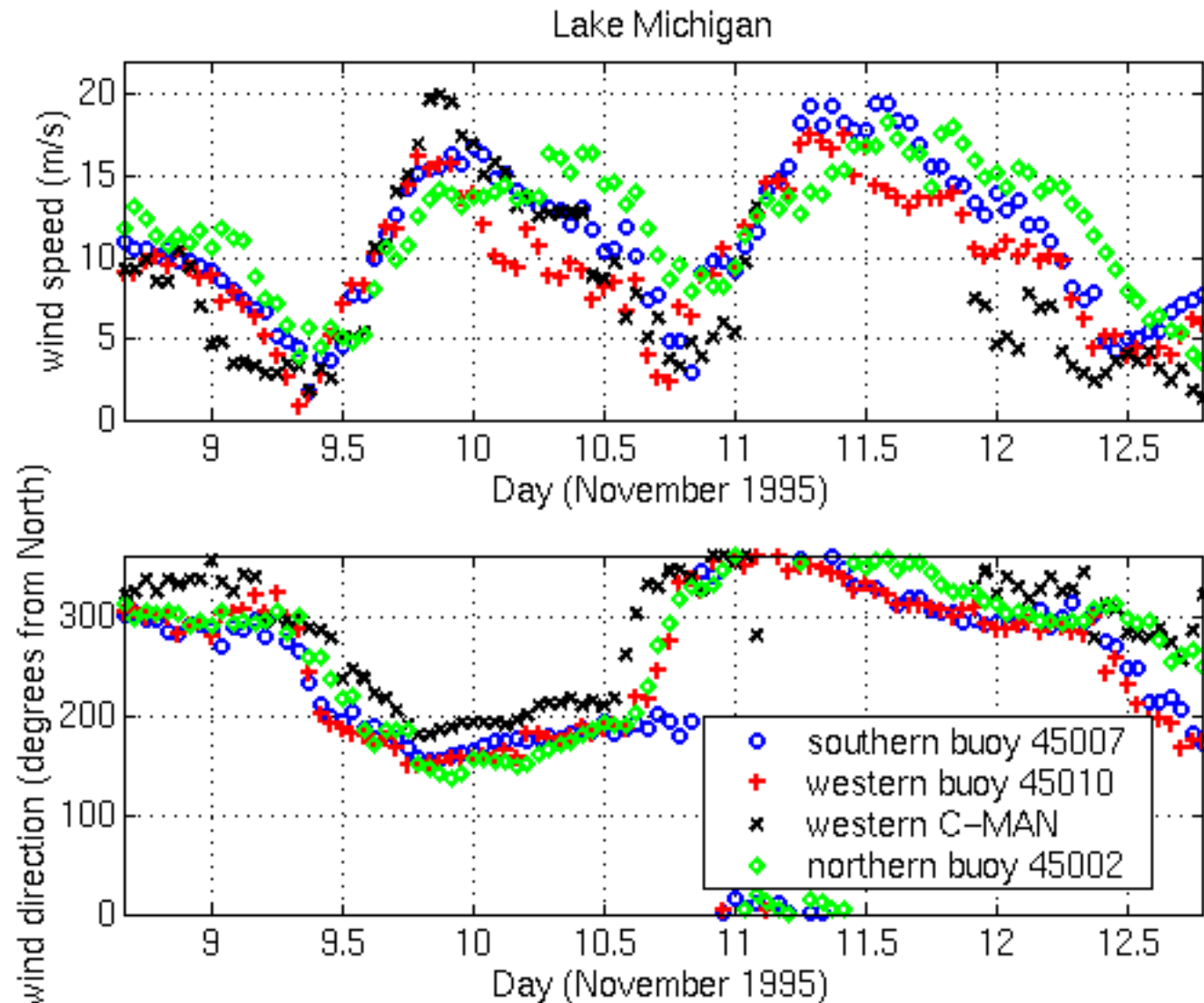
Concern: open ocean grid boundary (~ 400 km offshore)

Lake Michigan, Nov. 1995

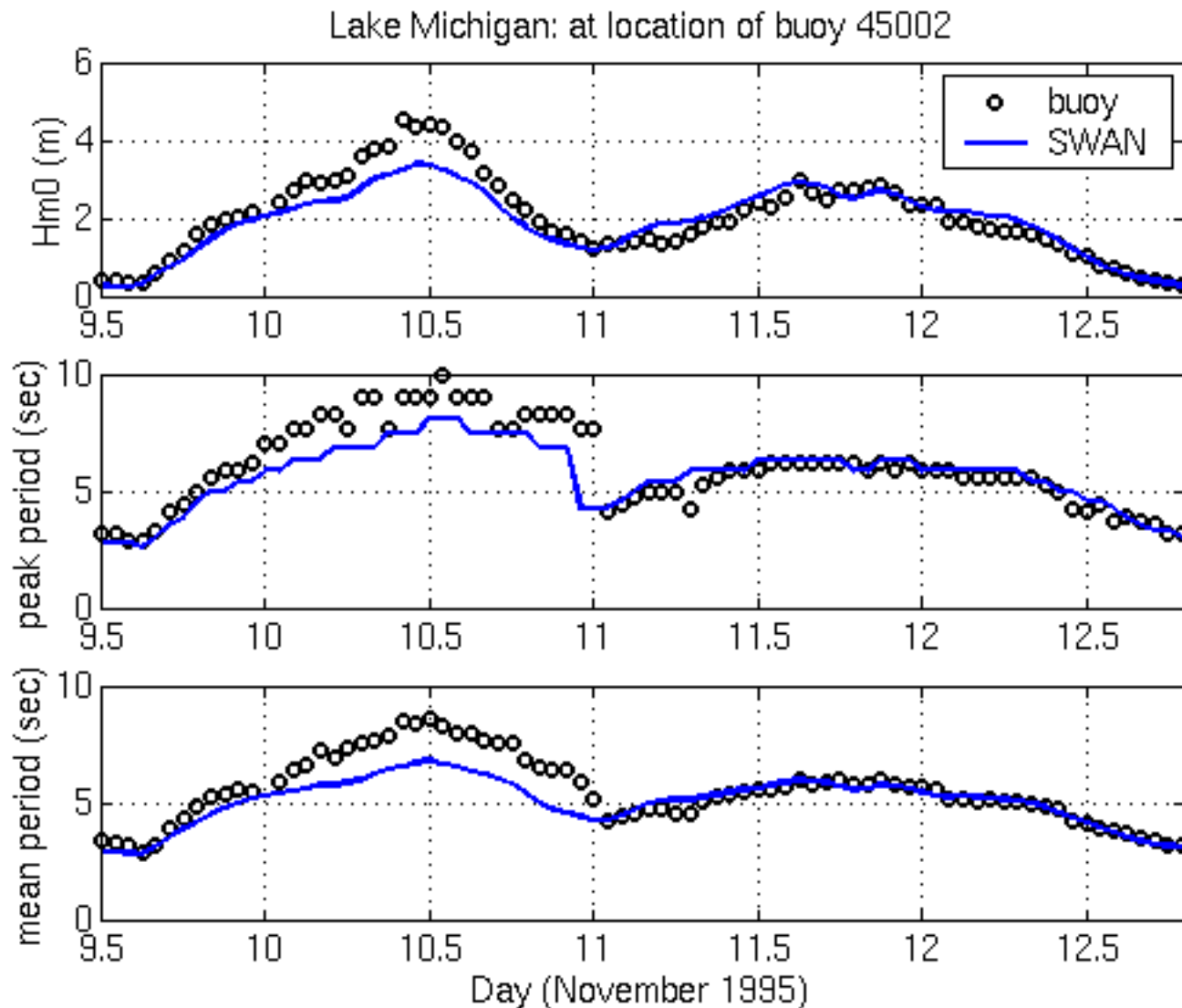
- Two-part storm event
- Forcing: wind data from 2 deep water NDBC buoys
- Computational resolution: 2km
- Output comparisons: deep water only



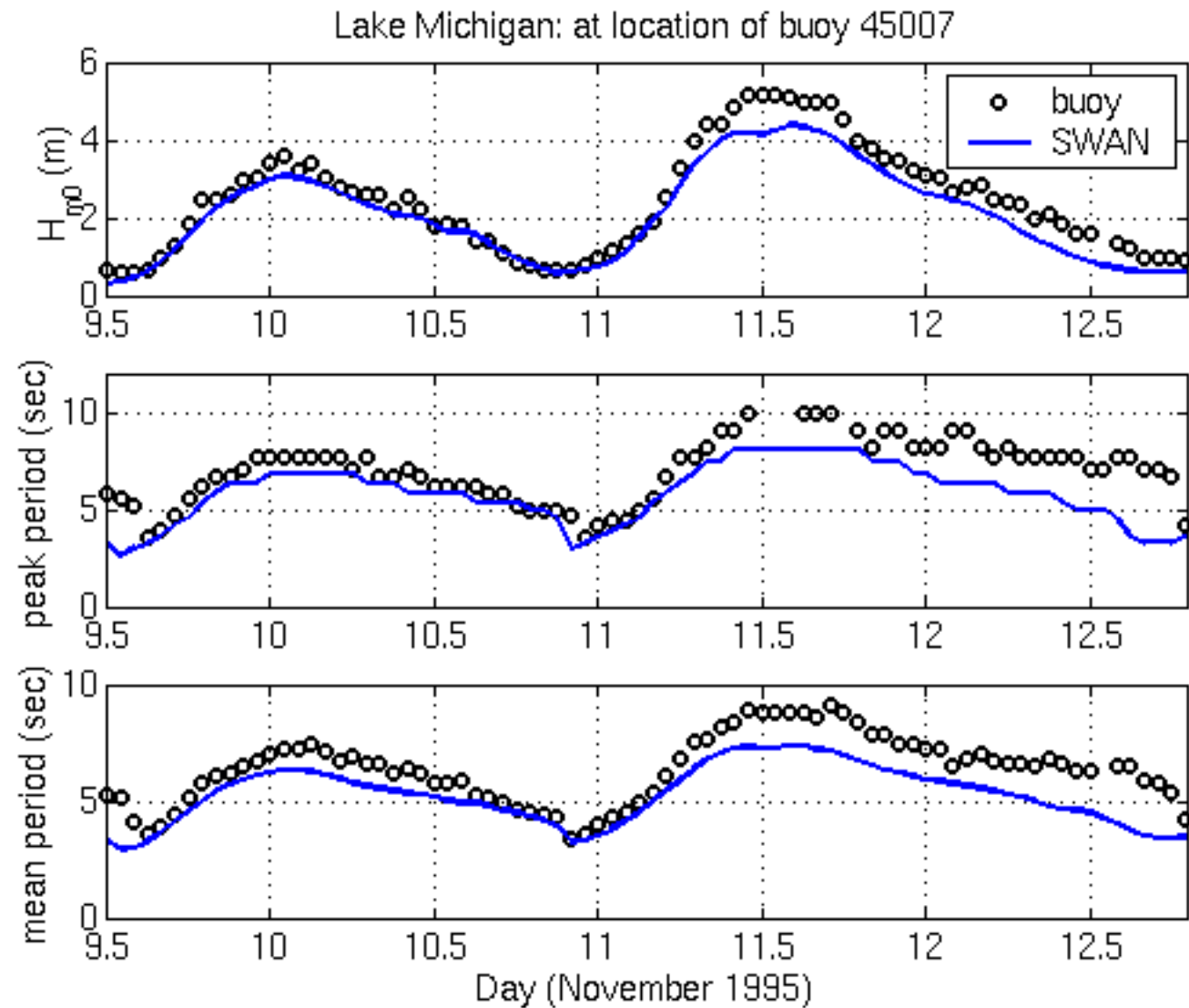
Wind Conditions



Results at northern buoy (45002)



Results at southern buoy (45007)



Alteration of deepwater source/sink terms

- Dissipation term is least well understood; arguably the least accurate. \Rightarrow greatest potential payoff
- work within framework of Komen et al. (1984) formulation, or create something completely new?
 - We take the former approach

Komen et al. (1984) dissipation mechanism:

Issue #1

$\beta_{Diss} E(\sigma, \theta)$: dissipation of wave action

$$\beta_{Diss}(\sigma, \theta) = C_{ds} \frac{\left| \frac{s}{s_{PM}} \right|^m}{\left| \frac{k}{k_m} \right|^n} \sigma_m$$

n affects the weighting of dissipation toward higher or lower frequencies. $n=1$ is traditionally used.

This choice is based on a) tuning to data in *fully-developed* conditions, and b) theoretical arguments of uncertainty.

We find that optimally, $1 < n < 1.5$.

We observe the expected effect of n on spectral shape:

A modified n requires a modified C_{ds} (for agreement with data).

Thus, the effect of n on total wave energy tends to be small.

Komen et al. (1984) dissipation mechanism: Issue #2

- The formulation is meant to represent the process of steepness-limited breaking.
- Under normal circumstances, swell does not break.
- We implement a switch to prevent this.
- Significant improvement in model skill.
- Care must be taken to allow for situations in which swell *is* expected to break.

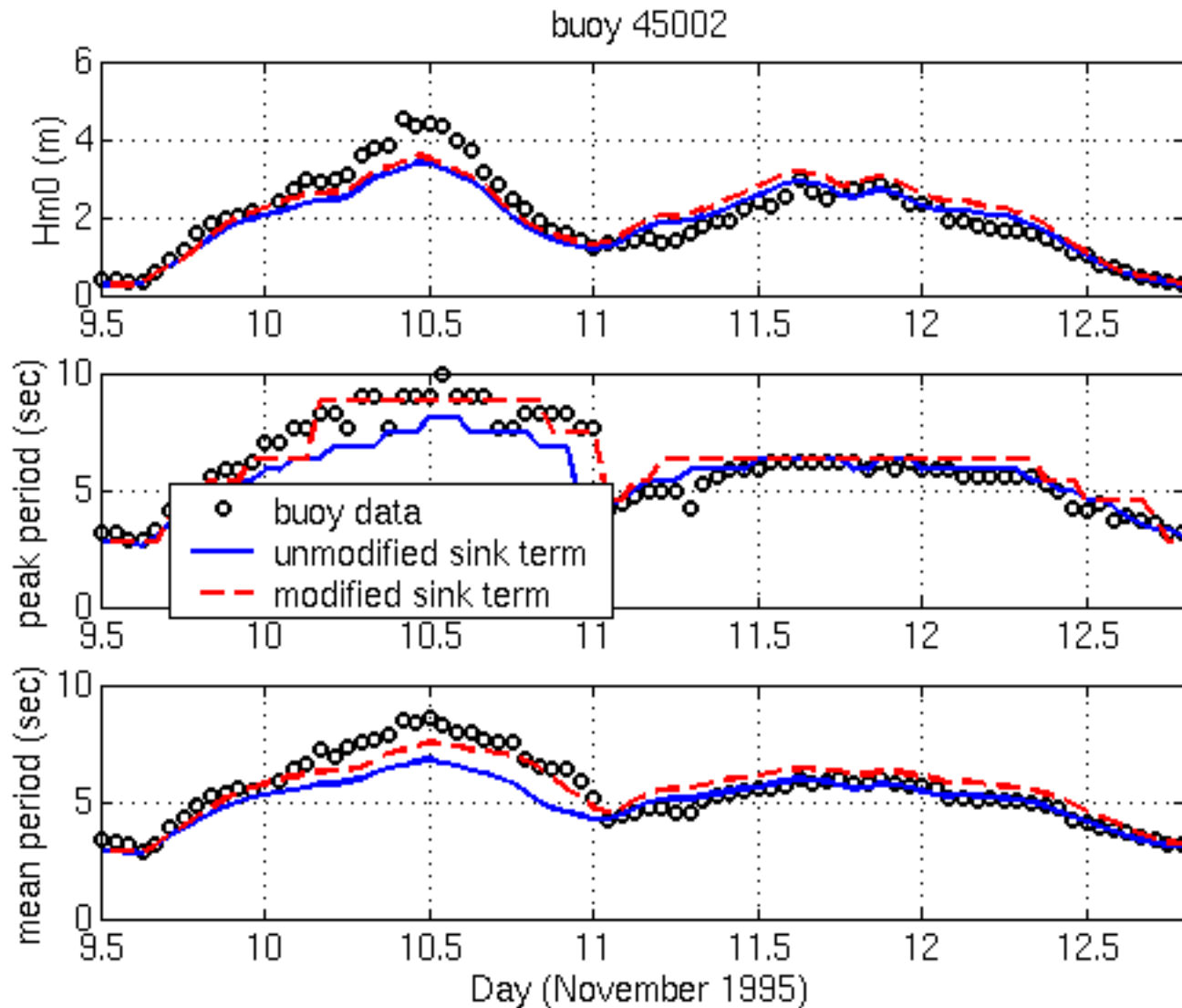
Komen et al. (1984) dissipation mechanism: Issue #3

- Dissipation at a given frequency is dependent on the mean steepness of the entire wave spectrum
 - Can produce aphysical results (e.g. as demonstrated by van Vledder (1999))
 - Might be addressed by treating dissipation of wave components separately.

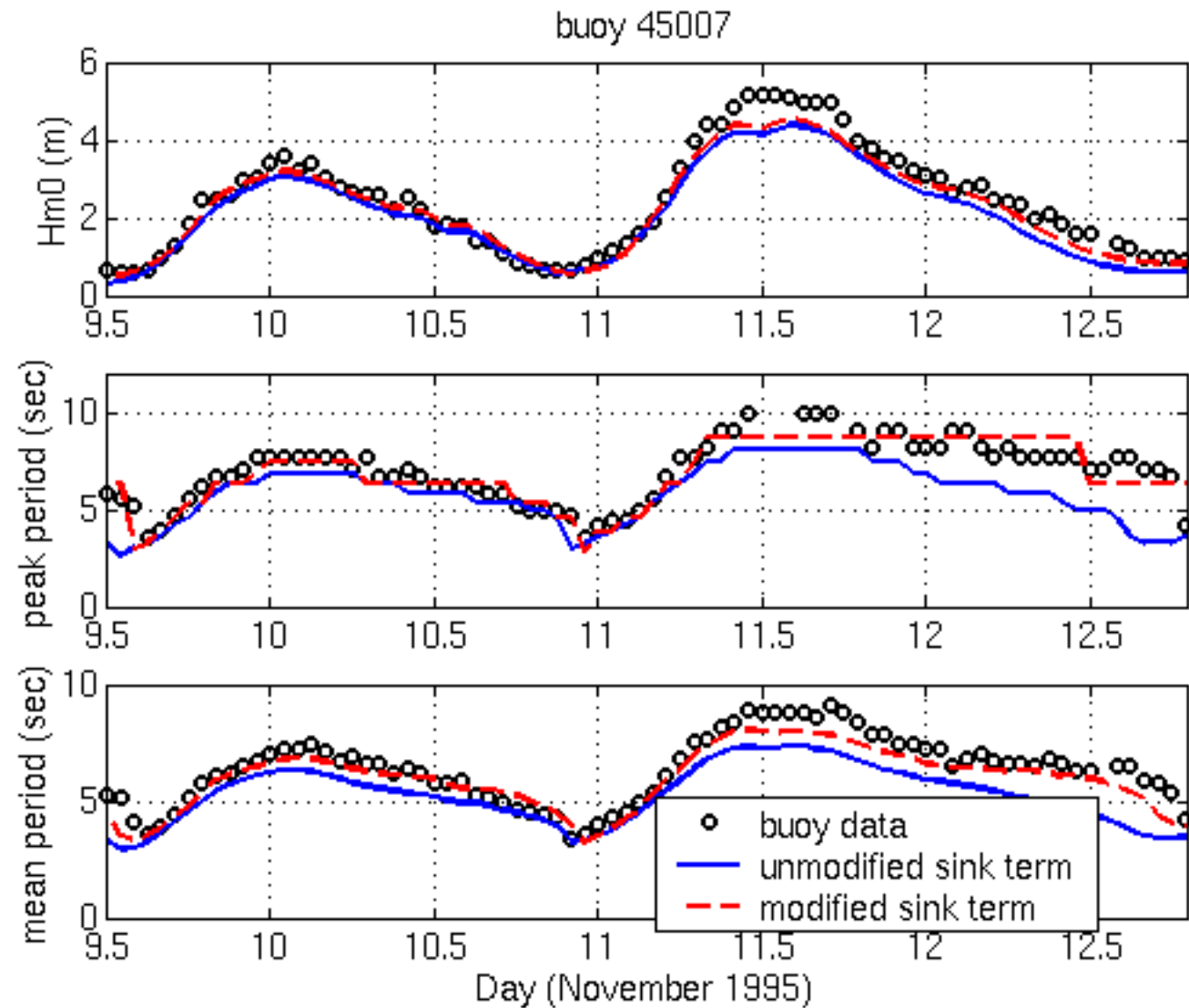
Calculated relative error values for Lake Michigan simulations

		NDBC buoy 45002			NDBC buoy 45007		
Param eter	Swell breaks?	n=1	n=1.5	n=2	n=1	n=1.5	n=2
H_{m0}	yes	0.18	0.22	0.25	0.16	0.22	0.26
	no	0.23	0.18	0.19	0.09	0.11	0.18
T_{mean}	yes	0.15	0.11	0.09	0.19	0.13	0.09
	no	0.12	0.10	0.09	0.12	0.09	0.07
T_{peak}	yes	0.15	0.12	0.12	0.22	0.16	0.11
	no	0.14	0.11	0.12	0.11	0.10	0.10

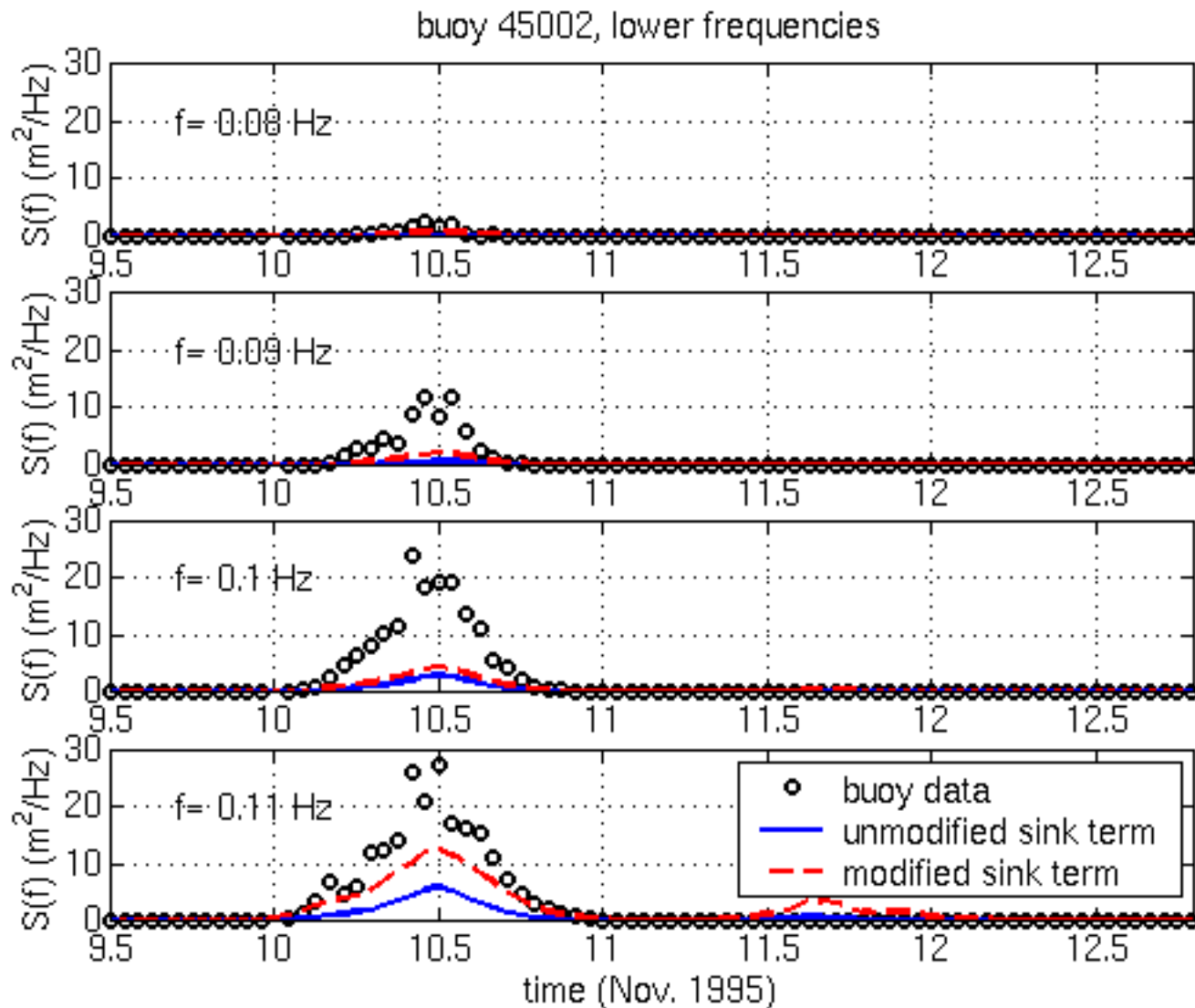
New results at northern buoy (45002)



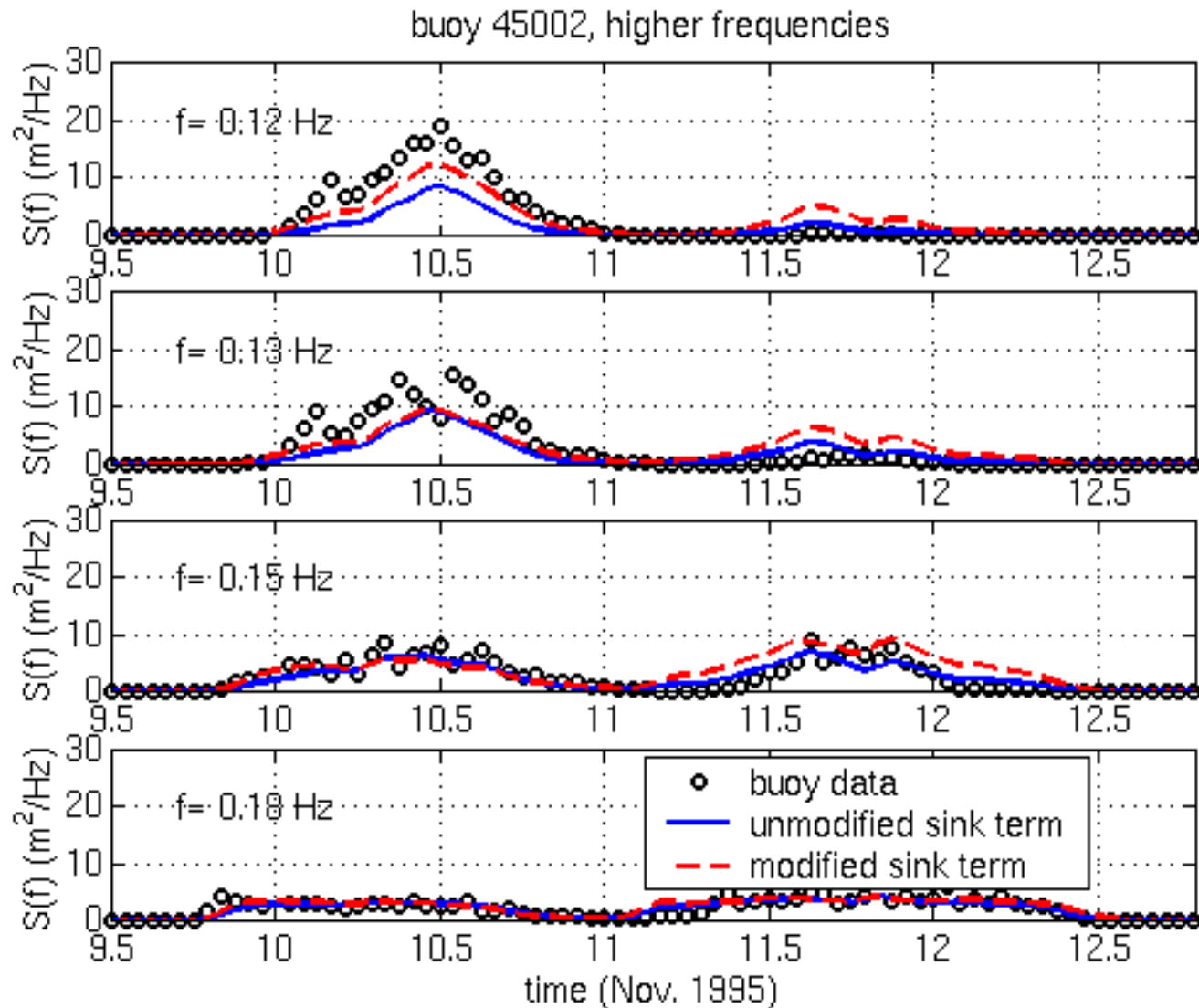
New results at southern buoy (45007)



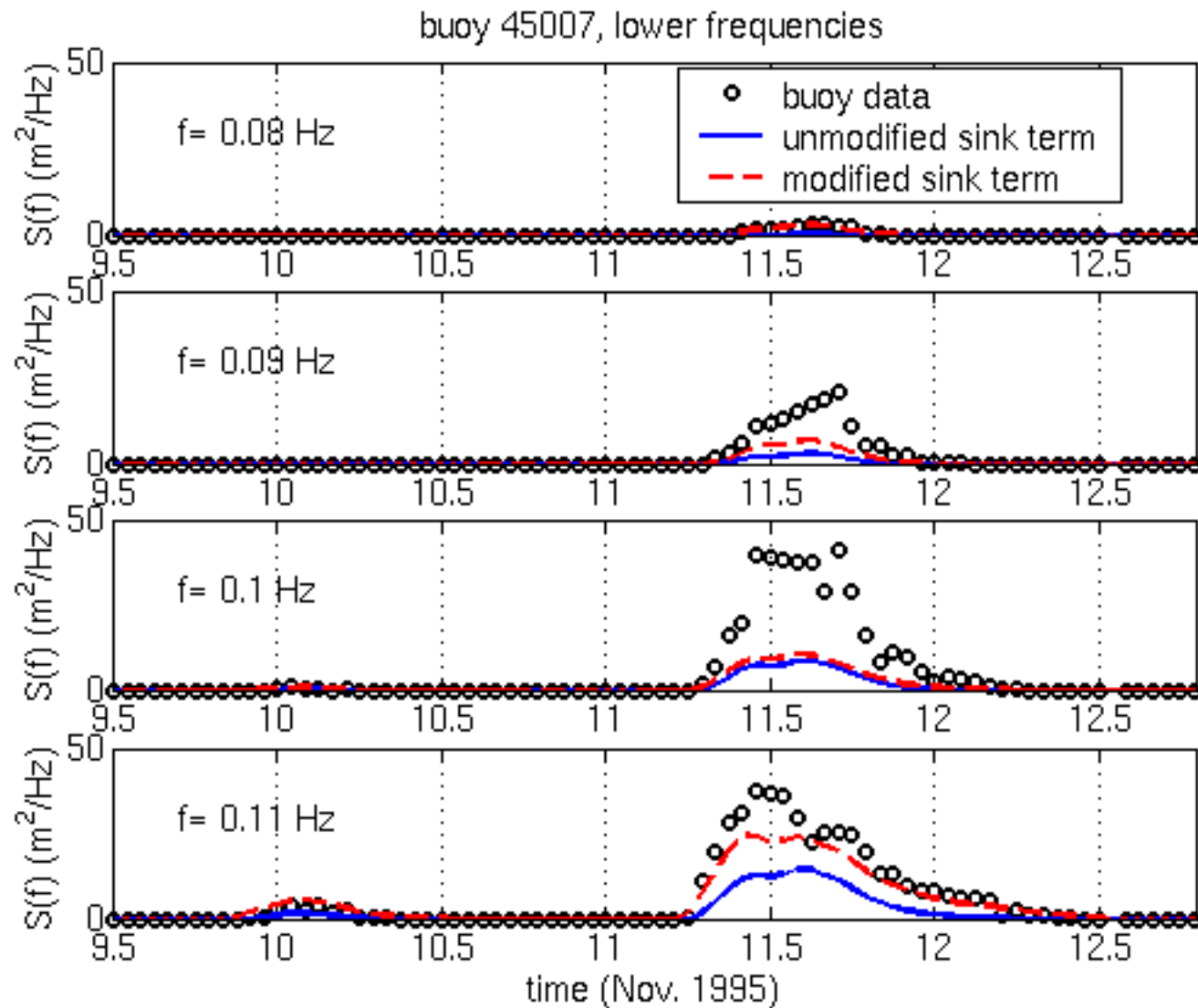
New results at northern buoy (45002)



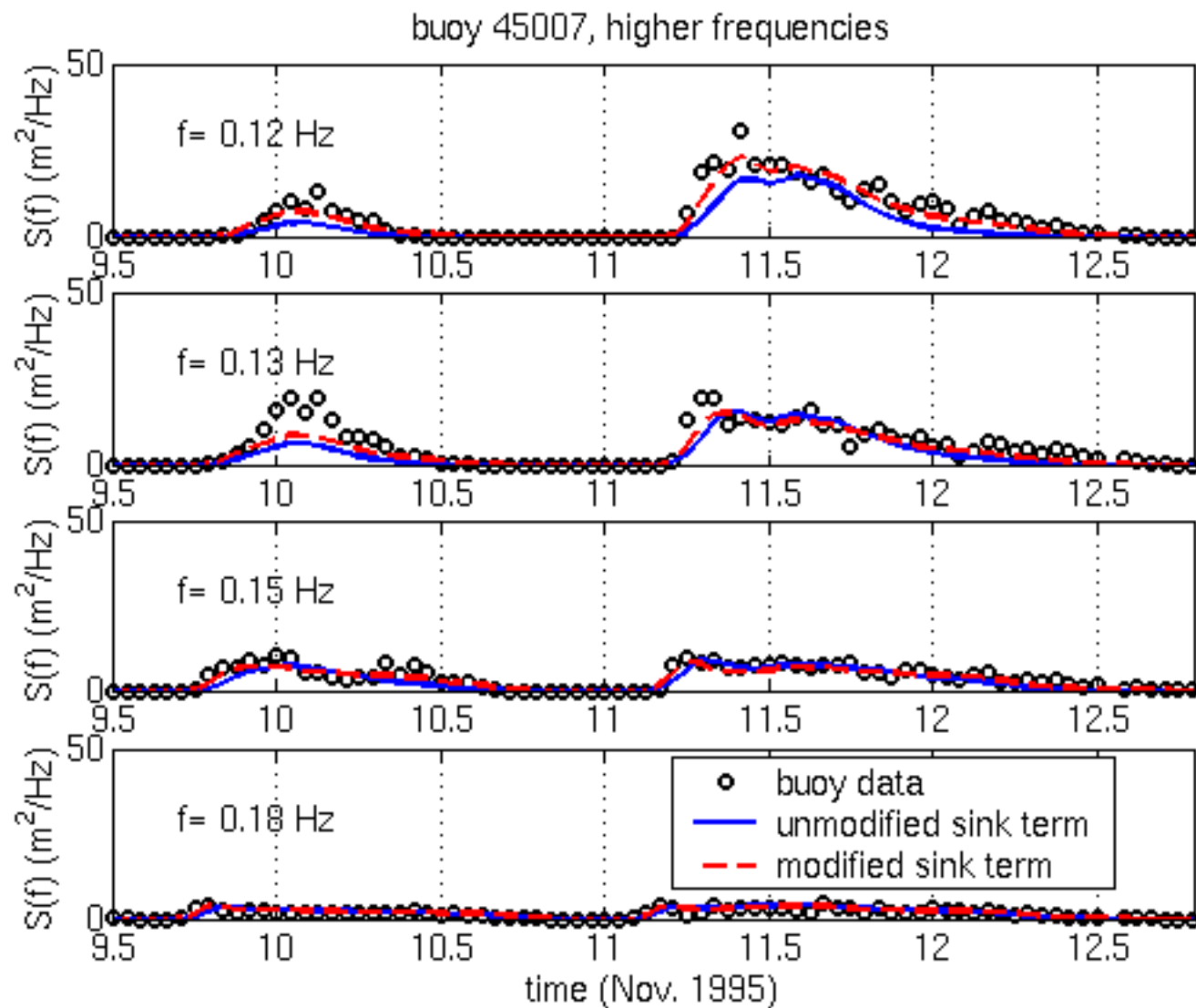
New results at northern buoy (45002)

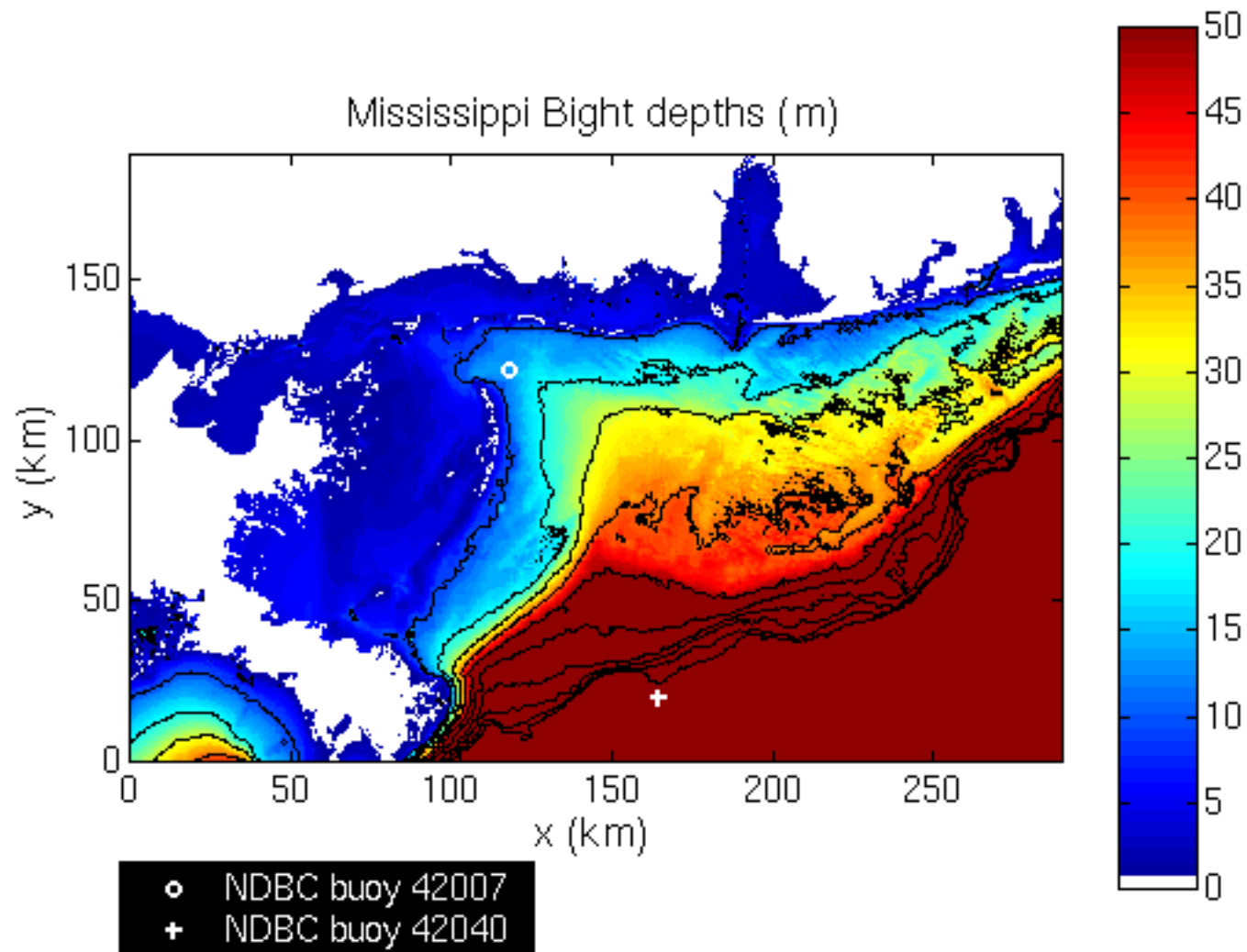


New results at southern buoy (45007)

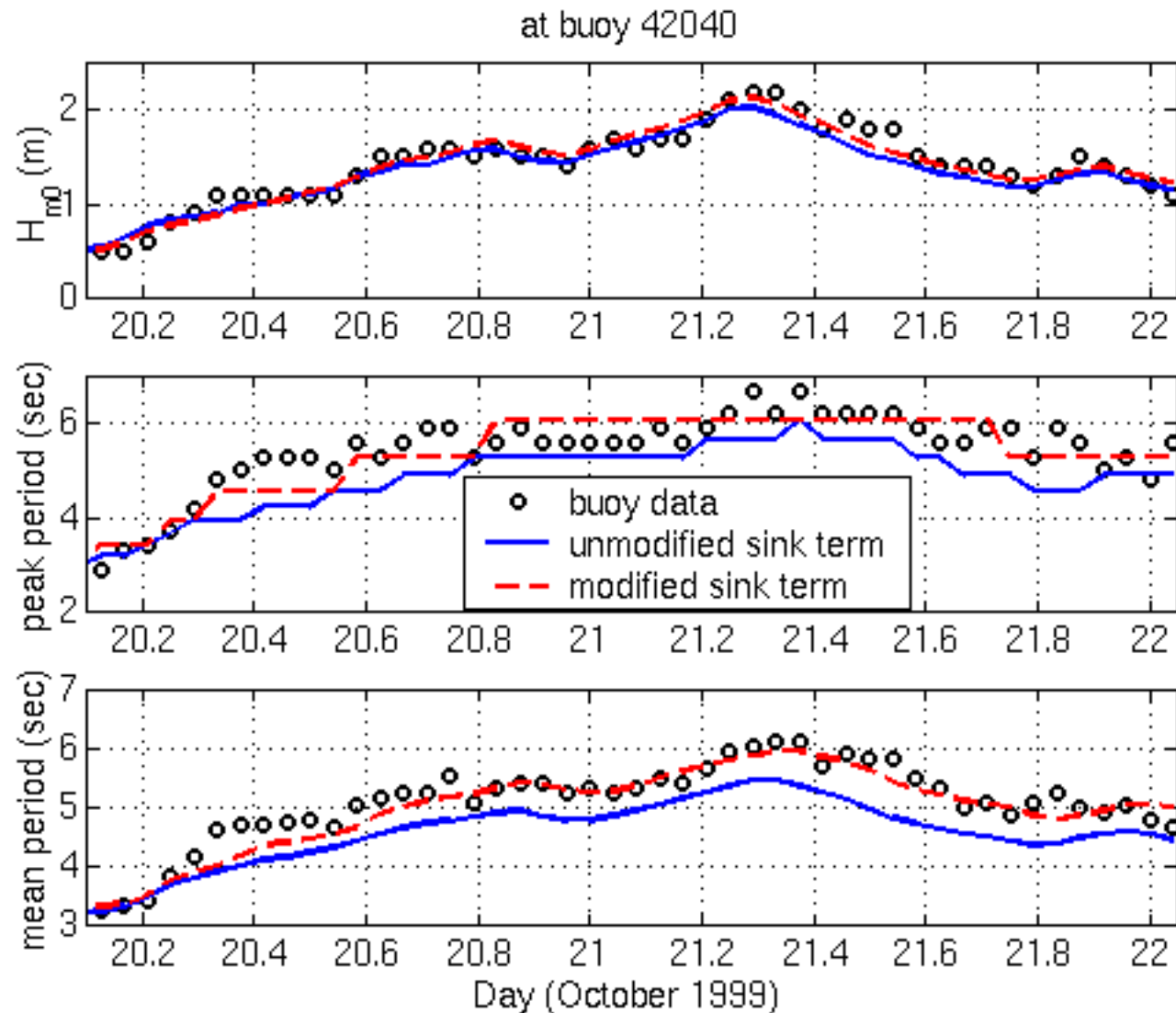


New results at southern buoy (45007)

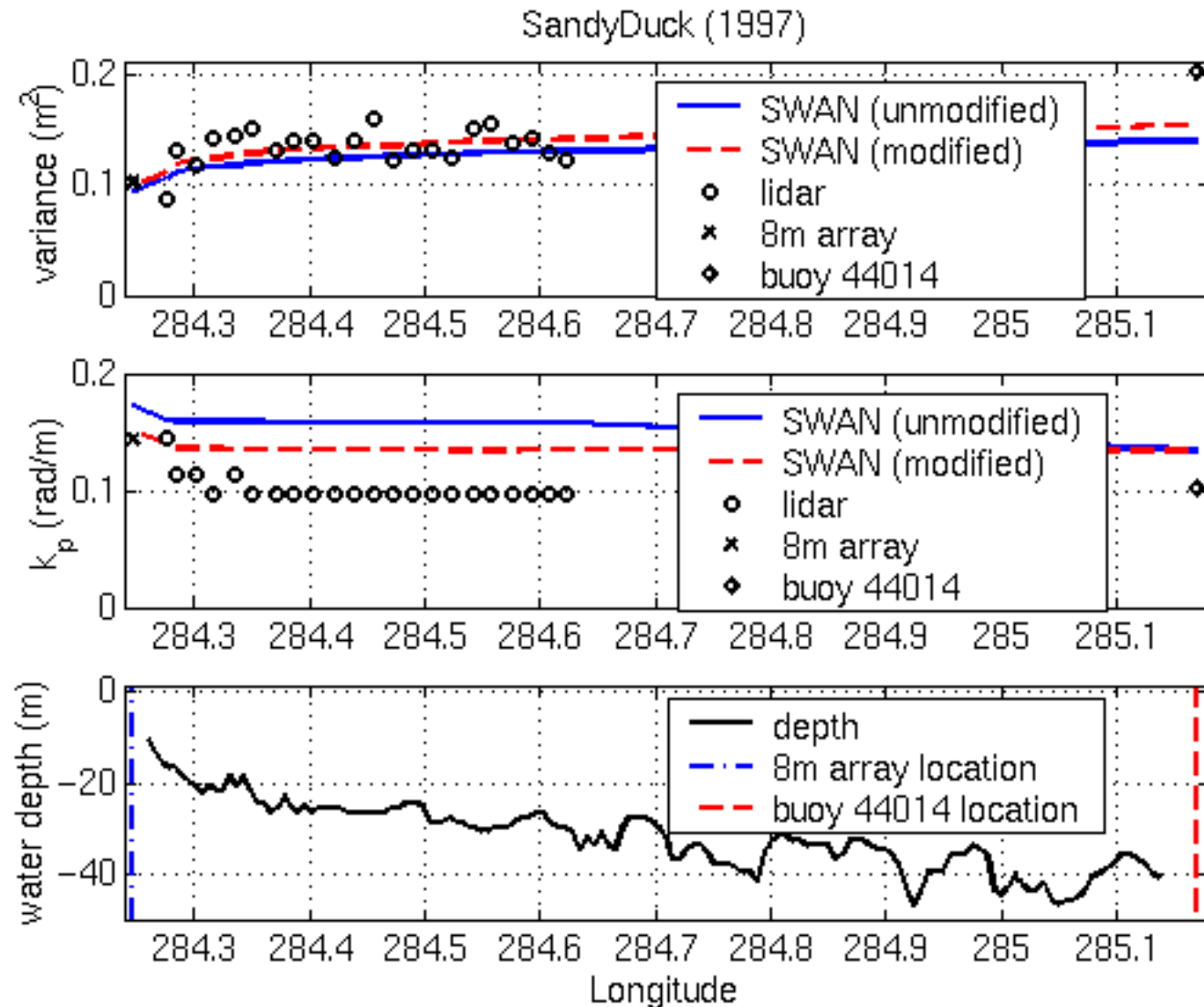




MS Bight: Comparison between NDBC buoy 42040 and SWAN (fetch limited case)



SandyDuck (1997): new results



Summary

- alteration of n (weighting of dissipation toward higher or lower frequencies): minor effect on results (due to P-M “shackles”).
- “swell does not break under normal conditions” rule: significant pay-off.
- Aphysical dependence of wave breaking on total steepness: not addressed yet.

Concerns

- The other two source terms (e.g. DIA)
- Tail representation (e.g. Banner and Young (1994))
- Wind forcing
- S_{wcap} : may be better to start over from scratch.
- Directional behavior